STEERING SYSTEM - VARIABLE EFFORT

1996 STEERING General Motors Corp. - Variable Effort Steering

DESCRIPTION & OPERATION

Variable Effort Steering (VES) system varies the effort required to rotate the steering wheel by varying the power steering fluid flow rate in accordance with the vehicle speed. As vehicle speed increases, power steering pump fluid flow rate is decreased which provides the driver with firmer steering (road) feel and directional stability at high speeds. VES system consists of a Power Steering Control Module (PSCM), power steering solenoid actuator, steering wheel speed sensor and connecting hydraulic lines and electrical wiring.

The PSCM process vehicle speed information from Powertrain Control Module (PCM) and input signal from steering wheel speed sensor. The steering wheel speed sensor determines steering wheel rotating speed and delivers input signal to allow for full power steering assist during a quick maneuver. The PSCM then delivers a Pulse Width Modulated (PMW) output signal to power steering pump actuator. The power steering pump actuator uses the PMW signal from PSCM and moves a pintle into the orifice in the power steering pump to regulate fluid flow rate from power steering pump. A check valve is located on the inlet hose at steering gear assembly. Check valve reduces the amount of steering wheel movement when driving over rough surfaces while operating at speeds with reduced fluid flow rate from power steering pump.

TESTING

POWER STEERING PUMP TESTING

NOTE: For power steering pump testing, see TESTING under LUBRICATION in STEERING SYSTEM - POWER RECIRCULATING BALL article.

VARIABLE EFFORT STEERING (VES) SYSTEM FUNCTION TEST

1. Disconnect electrical connector from Power Steering Control Module (PSCM). The PSCM is located to the left of steering column, near firewall and contains a Black 8-Pin electrical connector. See **Fig. 1**.
2. Remove Dark Green/White wire from terminal A2 on the electrical connector for PSCM. See **Fig. 2**. A jumper wire is to be installed in place of Dark Green/White wire on the electrical connector. Install a electrical connector terminal Part No. 12015870 on a one foot long jumper wire made of 18 guage wire. Install electrical connector terminal on jumper wire in cavity on electrical connector for PSCM.
3. Strip remaining end of jumper wire and connect to Red lead on Signal Generator (J-38522). Clip Black lead of signal generator to a good ground. Reinstall electrical connector on PSCM. Connect Tech 1 scan tool to Data Link Connector (DLC). The DLC is attached to instrument panel at right side of steering column.
4. Install cartridge for Anti-Lock Brake System (ABS) in Tech 1 scan tool. Select VES DUTY CYCLE TEST on Tech 1 scan tool. Ensure signal generator is not plugged in at this time.
5. Start engine. With engine idling, rotate steering wheel in half turns quickly to the left and right 3 times while noting duty cycle on Tech 1 scan tool and amount of power steering assist. No change in duty cycle should exist and full power steering assist should exist with no lag or decrease in the assist. Go to next

step.

6. Plug in signal generator. Set signal generator for a 5-volt square wave at 30 Hz with a 50 percent duty cycle. Duty cycle should increase to approximately 42-52 percent. Go to next step.
7. Increase frequency on signal generator to 60 Hz. Duty cycle should now increase to approximately 57-67 percent. Go to next step.
8. Rotate steering wheel in half turns quickly to the left and right 3 times while noting duty cycle on Tech 1 scan tool and amount of power steering assist. Duty cycle should decrease rapidly and return to the previous duty cycle with a low of approximately 35-45 percent. A noticeable decrease in power steering assist should exist at the beginning of the turns. Go to next step.
9. If VES system operates correctly in all previous steps, the system is operating properly. If VES system operates incorrectly in any of the previous steps, go to next step.
10. Turn engine off. Unplug signal generator. Install power steering pressure tester using proper procedure for checking power steering pump pressure. See TESTING under LUBRICATION in **STEERING SYSTEM - POWER RECIRCULATING BALL** article. Start engine and warm engine to normal operating temperature.
11. Allow engine to idle while noting duty cycle and power steering pump pressure. Duty cycle should be approximately 20-30 percent and power steering pump pressure should be approximately 150 psi (10.5 kg/cm^2).
12. Plug in signal generator. Set signal generator for a 5-volt square wave at 60 Hz with a 50 percent duty cycle. Duty cycle should increase to approximately 57-67 percent and power steering pump pressure should decrease to approximately 50 psi (3.5 kg/cm^2). Shut engine off.

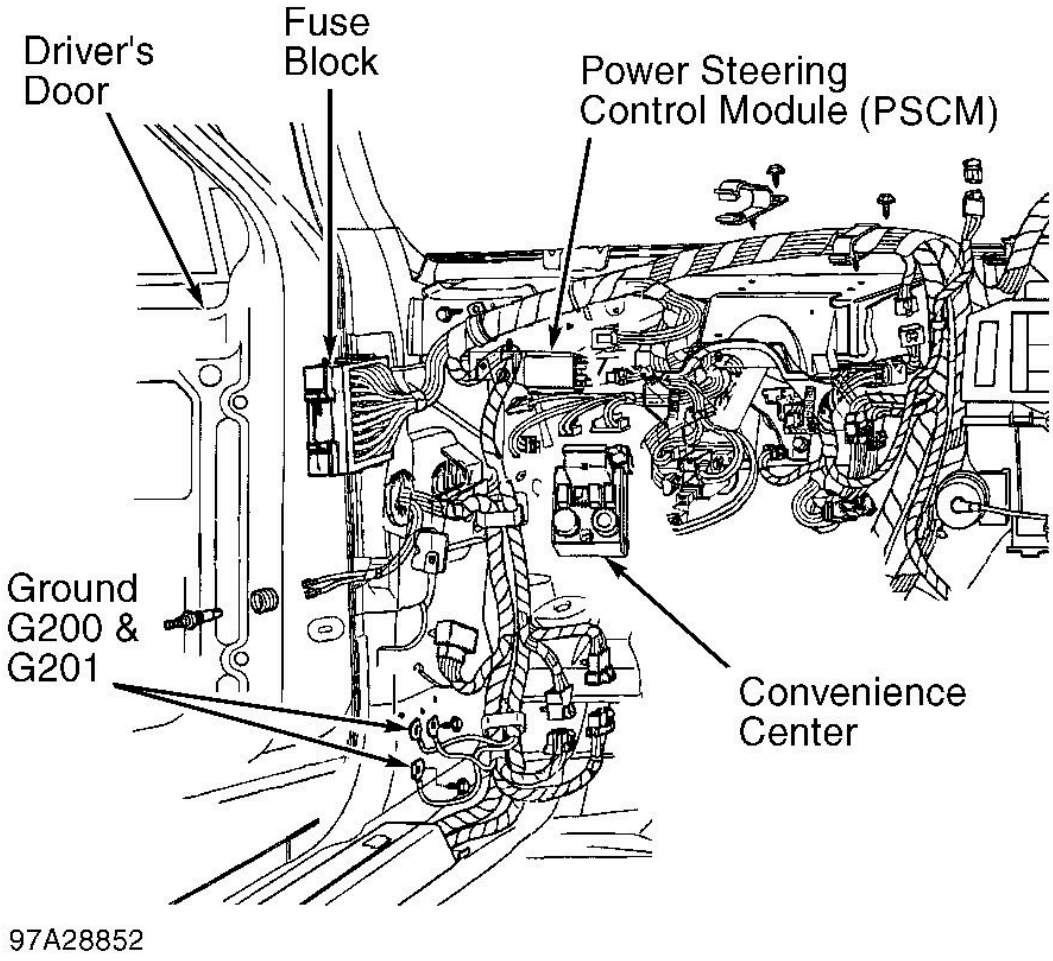

Fig. 1: Locating Power Steering Control Module (PSCM) & Grounds G200 & G201
Courtesy of GENERAL MOTORS CORP.

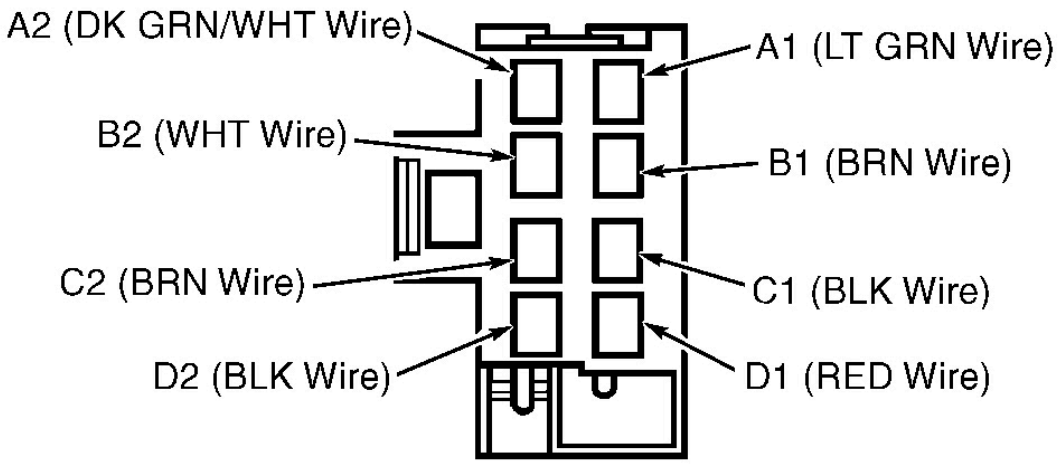

Fig. 2: Identifying Terminals On Electrical Connector For PSCM
Courtesy of GENERAL MOTORS CORP.

FULL ASSIST AT ALL TIMES (DECREASED ROAD FEEL, VES SYSTEM INOPERATIVE)

1. Check for inoperative speedometer, cruise control and use Tech 1 scan tool to check for stored Diagnostic Trouble Code (DTC) for the Vehicle Speed Sensor (VSS) in the Powertrain Control Module (PCM). If speedometer and cruise control is inoperative and DTC exists for the VSS, repair Vehicle Speed Sensor (VSS) circuit. See **G - TESTS W/CODES** article in ENGINE PERFORMANCE section. If speedometer and cruise control operate and no DTC exists for the VSS, go to next step.
2. Perform system function Variable Effort Steering (VES) system function test. See **VARIABLE EFFORT STEERING (VES) SYSTEM FUNCTION TEST** under TESTING. If VES system does not operate properly, go to step 4). If VES system operates correctly, go to next step.
3. Check for defective connections at terminal A2 (Dark Green/White wire) at PSCM. See **Fig. 2**. The PSCM is located to the left of steering column, near firewall and contains a Black 8-Pin electrical connector. See **Fig. 1**. If connections are okay, repair open circuit on Dark Green/White wire between PSCM and PCM. The PCM is located below air cleaner at driver's side front corner of engine compartment.
4. Turn ignition off. Ensure signal generator is set at 60 Hz. Plug signal generator on. While observing Tech 1 scan tool, turn ignition on and note duty cycle or message displayed on Tech 1 scan tool. Using duty cycle or message displayed on Tech 1 scan tool, proceed to appropriate test procedure listed below.

Duty Cycle Of Approximately 20-30 Percent

1. Turn ignition off. Disconnect electrical connector from Power Steering Control Module (PSCM). The PSCM is located to the left of steering column, near firewall and contains a Black 8-Pin electrical connector. See **Fig. 1**.

2. Disconnect electrical connector for steering wheel speed sensor. Steering wheel speed sensor is located in engine compartment, at base of steering column. See **Fig. 3**.

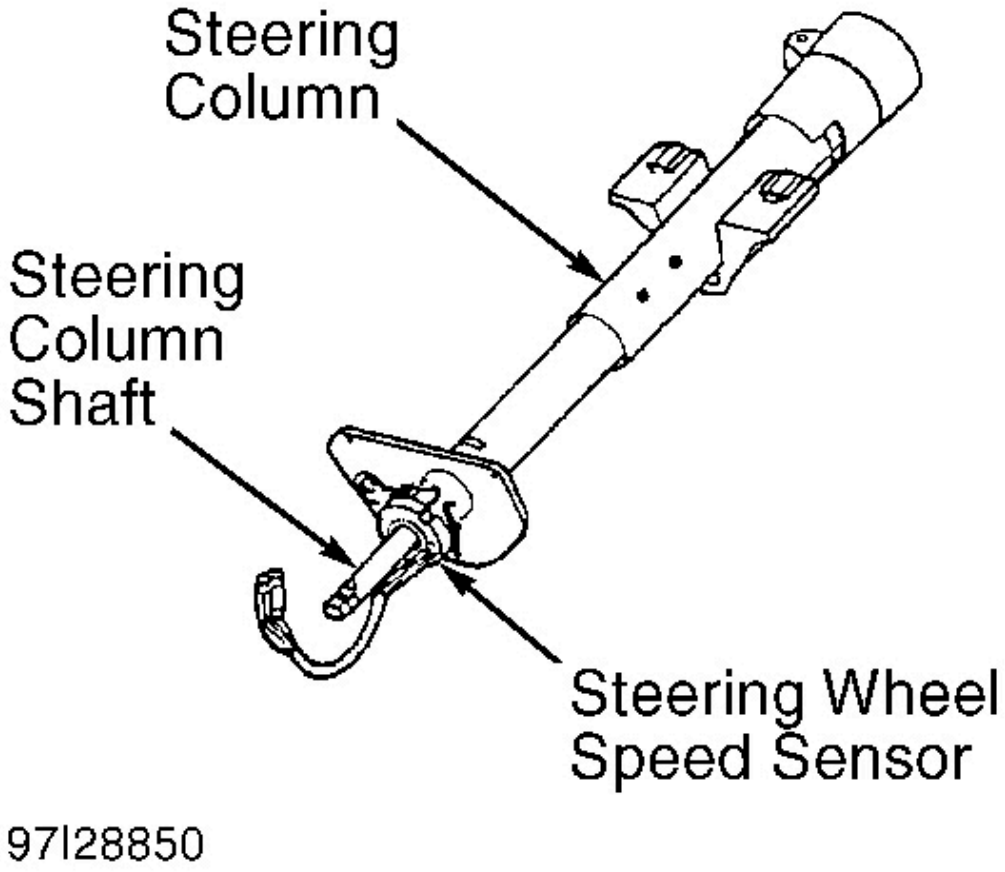

Fig. 3: Locating Steering Wheel Speed Sensor
Courtesy of GENERAL MOTORS CORP.

3. Turn ignition on. Using DVOM, check for open circuit, short to ground, short to battery voltage or poor connection at terminal A1 (Light Green wire), terminal D1 (Red wire) and terminal C1 (Black wire) between steering wheel speed sensor and PSCM. See **Fig. 2**. See **WIRING DIAGRAM**. If all circuits and connections are okay, go to next step. If any wire or connection is defective, repair wiring or connection as necessary.
4. Turn ignition off. Reinstall electrical connectors on steering wheel speed sensor and PSCM. Turn ignition on. Unplug signal generator. Using DVOM, check voltage between ground and terminal D1 (Red wire) on electrical connector for PSCM by backprobing the wire. See **Fig. 2**. Ensure electrical connector is installed on PSCM when checking voltage.

5. If voltage is 4.5-5.0 volts, go to step 7). If voltage is not 4.5-5.0 volts, turn ignition off. Disconnect electrical connector for steering wheel speed sensor. Ensure electrical connector is still installed on PSCM. Using DVOM, check voltage between ground and terminal D1 (Red wire) wire on electrical connector for PSCM by backprobing the wire.
6. If voltage is not 4.5-5.0 volts, replace steering wheel speed sensor. See **STEERING WHEEL SPEED SENSOR** under REMOVAL & INSTALLATION. If voltage is 4.5-5.0 volts, check for poor connection at terminal D1 (Red wire) at PSCM. If connection is defective, repair connection as necessary. If connection is okay, replace PSCM. See **POWER STEERING CONTROL MODULE (PSCM)** under REMOVAL & INSTALLATION.
7. Turn ignition off. Disconnect electrical connector for steering wheel speed sensor. Steering wheel speed sensor is located in engine compartment, at base of steering column. See **Fig. 3**.
8. Using DVOM, check resistance between terminal "A" (Red wire) and terminal "C" (Black wire) on electrical connector (sensor side) for steering wheel speed sensor. If resistance is 8000-15,000 ohms, go to next step. If resistance is not 8000-15,000 ohms, replace steering wheel speed sensor. See **STEERING WHEEL SPEED SENSOR** under REMOVAL & INSTALLATION.
9. Reinstall electrical connector for steering wheel speed sensor. Start engine. Using DVOM, check voltage between ground and terminal A1 (Light Green wire) on electrical connector for PSCM by backprobing the wire. See **Fig. 2**. While observing voltage reading, slowly rotate steering wheel at least 360 degrees.
10. Twice during steering wheel rotation, low voltage readings should be .45-.65 volt and high voltage readings should be 4.0-4.4 volts. Both low and high voltage readings should occur 180 degrees apart. Voltage should increase and decrease smoothly as steering wheel is rotated and should never decrease to less than .3 volt.
11. If voltage readings are as specified, go to next step. If voltage readings are not as specified, check for poor connection at steering wheel speed sensor and at terminal A1 (Light Green wire) and terminal C1 (Black wire) at connector for PSCM. See **Fig. 2**. If connections are okay, replace steering wheel speed sensor. See **STEERING WHEEL SPEED SENSOR** under REMOVAL & INSTALLATION.
12. Check for poor connection at terminal A1 (Light Green wire) terminal on PSCM. See **Fig. 2**. If poor connection exists, repair connection as necessary. If connection is okay, replace PSCM. See **POWER STEERING CONTROL MODULE (PSCM)** under REMOVAL & INSTALLATION.

Duty Cycle Of Approximately 57-67 Percent

1. Turn ignition off. Unplug signal generator. Remove power steering pump actuator from power steering pump. See **POWER STEERING PUMP ACTUATOR** under REMOVAL & INSTALLATION. Reinstall electrical connector on power steering pump actuator.
2. Turn ignition on. Ensure signal generator is unplugged. Set signal generator to 60 Hz. While using flashlight to observe operation of pintle through hole in power steering pump actuator, plug in signal generator for 3 or 4 seconds, and then unplug signal generator for 3 or 4 seconds for 2-3 times. If pintle does not move inward and outward, replace power steering pump actuator. If pintle moves inward and outward, system is operating properly, but an intermittent problem may exist.
3. To diagnose an intermittent problem, ensure signal generator is plugged in. Observe Tech 1 scan tool display while rotating steering wheel from full left to full right 2 or 3 times. Also, wiggle harness at steering wheel speed sensor and power steering pump actuator. Steering wheel speed sensor is located in engine compartment, at base of steering column. See **Fig. 3**.
4. If Tech 1 scan tool displays anything other than 57-67 percent duty cycle, return to step 4) under

VARIABLE EFFORT STEERING (VES) SYSTEM FUNCTION TEST and proceed with proper test procedure in accordance with display on Tech 1 scan tool.

No Duty Cycle Present

1. Turn ignition off. Disconnect electrical connector from Power Steering Control Module (PSCM). The PSCM is located to the left of steering column, near firewall and contains a Black 8-Pin electrical connector. See **Fig. 1**.
2. Connect a test light between positive battery terminal and terminal D2 (Black wire) on electrical connector for PSCM. See **Fig. 2**. If test light operates, go to next step. If test light does not operate on, check for defective connection at Black wire or repair open circuit in Black wire between terminal D2 on electrical connector and ground G200. Ground G200 is located behind driver's side kick panel. See **Fig. 1**.
3. Disconnect electrical connector from power steering pump actuator. Power steering pump actuator is located on rear of power steering pump. See **Fig. 4**.

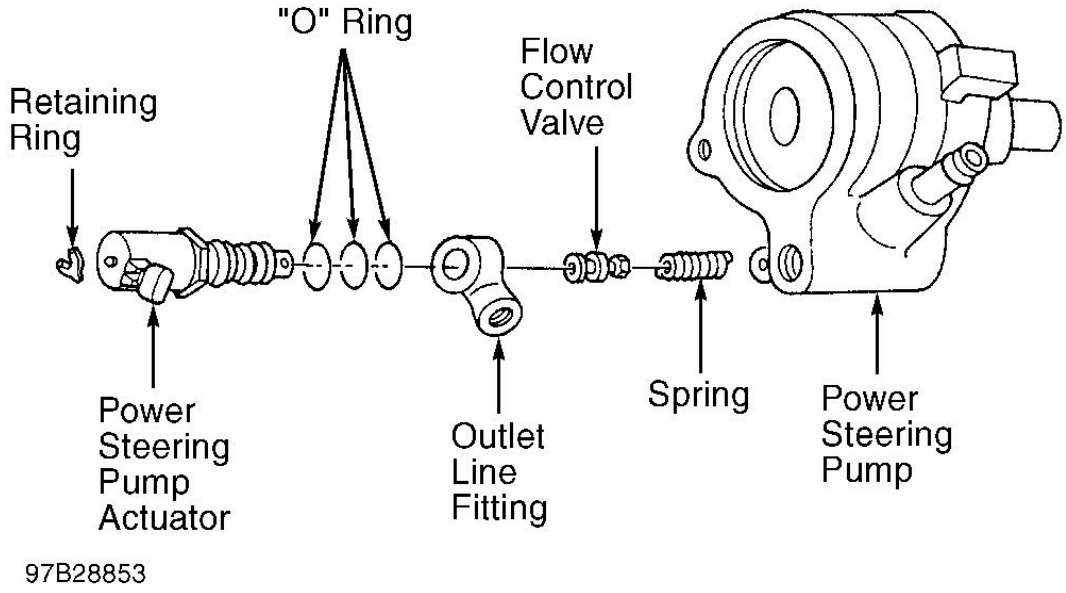

Fig. 4: Locating Power Steering Pump Actuator
Courtesy of GENERAL MOTORS CORP.

4. Using DVOM, check for open circuit, short to ground or short to battery voltage on Brown wire between terminal B1 on electrical connector for PSCM and electrical connector for power steering pump actuator. See **Fig. 2**. If circuit is okay, go to next step. If circuit is defective, repair circuit as necessary.
5. Using DVOM, check for short to battery voltage or open circuit on White wire between terminal B2 on electrical connector for PSCM, power steering pump actuator and Data Link Connector (DLC). See **WIRING DIAGRAM**. The DLC is attached to instrument panel at right side of steering column.
6. If all circuits are okay, check for poor connection at terminal B1 (Brown wire) on electrical connector for

PSCM. See **Fig. 2**. If connection is defective, repair connection as necessary. If connection is okay, replace PSCM. See **POWER STEERING CONTROL MODULE (PSCM)** under REMOVAL & INSTALLATION.

PIN "D" ALWAYS LOW Message Displayed

1. Turn ignition off. Disconnect electrical connector from Power Steering Control Module (PSCM). The PSCM is located to the left of steering column, near firewall and contains a Black 8-Pin electrical connector. See **Fig. 1**.
2. Connect a test light between ground and terminal C2 (Brown wire) on electrical connector for PSCM. See **Fig. 2**. Turn ignition on and note operation of test light.
3. If test light operates, go to next step 6). If test light does not operate, check for defective VES fuse No. 18 (20-amp) in fuse block. Fuse block is located on end of instrument panel at driver's side door opening.
4. If VES fuse is blown, replace fuse and recheck operation. If fuse blows again, check for short to ground on Brown wire between VES fuse No. 18 and terminal C2 at PSCM. See **Fig. 2**. Repair wiring as necessary.
5. If fuse is okay, check for open circuit between terminal C2 (Brown wire) on electrical connector for PSCM and VES fuse No. 18 (20-amp) in fuse block. If open circuit exists, repair wiring as necessary. If no open circuit exists, repair power supply to VES fuse No. 18.
6. Disconnect electrical connector from power steering pump actuator. Power steering pump actuator is located on rear of power steering pump. See **Fig. 4**.
7. Using DVOM, check for short to ground on White wire between terminal B2 on electrical connector for PSCM, power steering pump actuator and Data Link Connector (DLC). See **WIRING DIAGRAM**. The DLC is attached to instrument panel at right side of steering column.
8. If any circuit is grounded, repair wiring as necessary. If all circuits are okay, check for poor connection at terminal C2 (Brown wire) on electrical connector for PSCM. If connection is defective, repair connection as necessary. If connection is okay, replace PSCM. See **POWER STEERING CONTROL MODULE (PSCM)** under REMOVAL & INSTALLATION.

PIN "D" ALWAYS LOW Message Displayed For About 3 Seconds &

Then Duty Cycle Rapidly Changes From 25 To 80 Percent

1. Using DVOM, check for open circuit on White wire between terminal B2 on electrical connector for PSCM, power steering pump actuator and Data Link Connector (DLC). See **WIRING DIAGRAM**. The DLC is attached to instrument panel at right side of steering column. Power steering pump actuator is located on rear of power steering pump. See **Fig. 4**.
2. If any circuit is grounded, repair wiring as necessary. If all circuits are okay, check for poor connection at terminal B2 (White wire) on electrical connector for PSCM. If connection is defective, repair connection as necessary. If connection is okay, replace PSCM. See **POWER STEERING CONTROL MODULE (PSCM)** under REMOVAL & INSTALLATION.

DECREASED ASSIST AT ALL TIMES

1. Disconnect electrical connector from power steering pump actuator and note if symptom still exists.

Power steering pump actuator is located on rear of power steering pump. See **Fig. 4**.

2. If symptom no longer exists, go to next step. If symptom still exists, problem is not in VES system. Check mechanical and hydraulic power steering system. See TESTING under LUBRICATION in **STEERING SYSTEM - POWER RECIRCULATING BALL** article.
3. Check for inoperative speedometer and cruise control. If speedometer and cruise control operate properly, replace PSCM. See **POWER STEERING CONTROL MODULE (PSCM)** under REMOVAL & INSTALLATION. If speedometer and cruise control is inoperative, repair Vehicle Speed Sensor (VSS) circuit. See **G - TESTS W/CODES** article in ENGINE PERFORMANCE section.

LUBRICATION

HYDRAULIC SYSTEM BLEEDING

NOTE: If air was introduced into hydraulic system during servicing, bleed hydraulic system. Aerated fluid may result in poor steering performance and cause damage to power steering pump.

1. Turn ignition off. Raise and support vehicle with front wheels off ground. Turn wheels fully to the left. Add power steering fluid to FULL COLD mark on dipstick. Turn wheels from side to side several times. Add power steering fluid as necessary to maintain fluid level at FULL COLD mark.
2. Start engine. With engine idling, add power steering fluid as necessary to bring level to FULL COLD mark. Return wheels to center position. Lower vehicle. Continue to run engine for 2 minutes to eliminate trapped air and raise fluid to operating temperature. Turn wheels in both directions and check for smooth operation and proper fluid level.
3. Road test vehicle. Check for leaks. Ensure fluid level is at FULL HOT mark when fluid is stabilized at normal operating temperature.

ADJUSTMENTS

POWER STEERING PUMP DRIVE BELT

Power steering pump drive belt tension is automatically adjusted by automatic adjuster and no tension adjustment is required.

REMOVAL & INSTALLATION

POWER STEERING CONTROL MODULE (PSCM)

Removal & Installation

1. The PSCM is located to the left of steering column, near firewall and contains a Black 8-Pin electrical connector. See **Fig. 1**.
2. Disconnect negative battery cable. Disconnect necessary components on convenience center for access to PSCM. Disconnect electrical connector from PSCM. Remove retaining screws and PSCM from mounting

bracket.

3. To install, reverse removal procedure. Tighten retaining screws to specification. See **TORQUE SPECIFICATIONS**.

POWER STEERING PUMP ACTUATOR

Removal

1. Manufacturer recommends removing power steering pump for servicing of power steering pump actuator. Remove power steering pump. See POWER STEERING PUMP under REMOVAL & INSTALLATION in **STEERING SYSTEM - POWER RECIRCULATING BALL** article.
2. Place reference mark on power steering pump and outlet line fitting for installation reference. See **Fig. 4**. Note location of electrical connector terminals on power steering pump actuator for installation reference.
3. Remove retaining clip, power steering pump actuator with outlet line fitting from power steering pump. Remove outlet line fitting and "O" rings from power steering pump actuator.

Installation

1. To install, reverse removal procedure using NEW "O" rings. Lubricate "O" rings with power steering fluid before installing on power steering pump actuator.
2. Ensure all reference marks are aligned and electrical connector terminals on power steering pump actuator are positioned in original location. Electrical connector terminals should be facing away from the engine.
3. Tighten power steering pump actuator to specification. See **TORQUE SPECIFICATIONS**. Reinstall power steering pump. Fill and bleed hydraulic system. See **HYDRAULIC SYSTEM BLEEDING** under LUBRICATION.

STEERING WHEEL SPEED SENSOR

Removal

1. Steering wheel speed sensor is located in engine compartment, at base of steering column. See **Fig. 3**.

CAUTION: Wheels must be in straight ahead position and ignition in LOCK position before servicing steering wheel rotation sensor to prevent damage to Supplemental Inflatable Restraint (SIR) coil on steering column.

2. Ensure wheels are in straight ahead position. Turn ignition to LOCK position and remove key. Disconnect negative battery cable.
3. In engine compartment, remove intermediate shaft coupling bolt retaining intermediate shaft on lower end of steering column shaft. Slide coupling with intermediate shaft from lower end of steering column shaft.
4. Disconnect electrical connector for steering wheel speed sensor. Remove retaining clip located at base of steering column. Remove steering wheel rotation sensor from steering column.

Installation

To install, reverse removal procedure. Tighten intermediate shaft coupling to specification. See **TORQUE SPECIFICATIONS**.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Intermediate Shaft Coupling Bolt	40 (54)
Power Steering Pump Actuator	46 (62)
	INCH Lbs. (N.m)
PSCM Retaining Screw	17 (1.9)

WIRING DIAGRAM

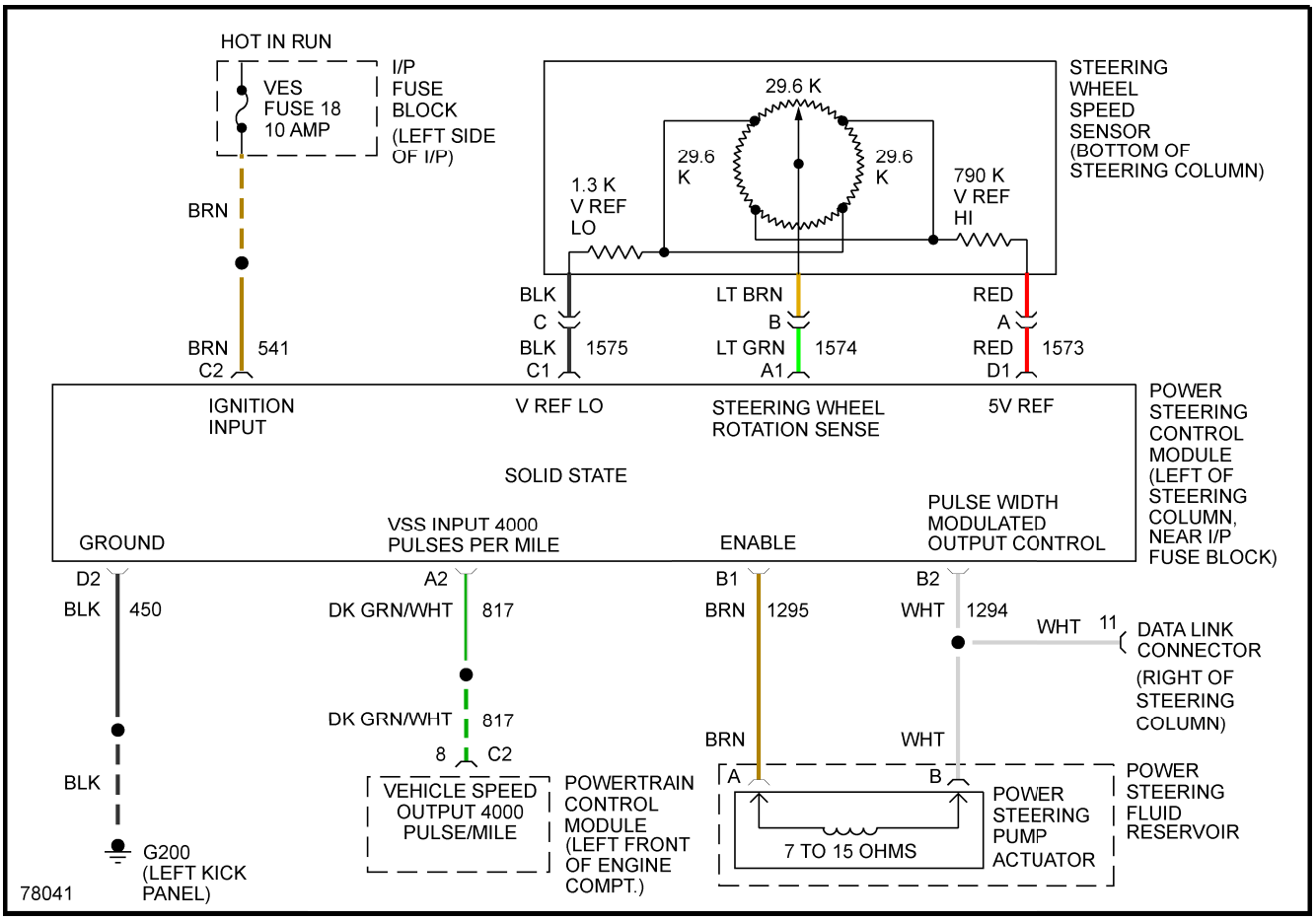
HOT IN RUN
I/P FUSE BLOCK (LEFT SIDE OF I/P)
VES FUSE 18 10 AMP
BRN
BRN C2 541
IGNITION INPUT
29.6 K
29.6 K
29.6 K
1.3 K V REF LO
790 K V REF HI
STEERING WHEEL SPEED SENSOR (BOTTOM OF STEERING COLUMN)
BLK C
BLK C1 1575
V REF LO
LT BRN B
LT GRN A1 1574
STEERING WHEEL ROTATION SENSE
RED A
RED D1 1573
5V REF
SOLID STATE
POWER STEERING CONTROL MODULE (LEFT OF STEERING COLUMN, NEAR I/P FUSE BLOCK)
GROUND
VSS INPUT 4000 PULSES PER MILE
ENABLE
PULSE WIDTH MODULATED OUTPUT CONTROL
D2
BLK 450
BLK
G200 (LEFT KICK PANEL)
A2
DK GRN/WHT 817
DK GRN/WHT 817
8 C2
VEHICLE SPEED OUTPUT 4000 PULSE/MILE
POWERTRAIN CONTROL MODULE (LEFT FRONT OF ENGINE COMPT.)
B1
BRN 1295
BRN
B2
WHT 1294
WHT 11
DATA LINK CONNECTOR (RIGHT OF STEERING COLUMN)
WHT
A
B
7 TO 15 OHMS
POWER STEERING PUMP ACTUATOR
POWER STEERING FLUID RESERVOIR
78041

Fig. 5: Variable Effort Steering (VES) System Wiring Diagram (Roadmaster)